Section 4 - Evaluation of personal FM systems for individual children

Subjective and objective evaluation of a personal FM system to determine its benefit must be carried out at least annually.

How can I measure the benefit of the system?

Evaluation – good practice
(i) Gathering information about and recording specific problems or barriers to the use of a personal FM system, as well as subjective and objective measures, are important in order to obtain as complete a picture of benefit as possible.

The information from the evaluation can be collated and used to:

- inform Individual Education Plans eg target setting on use or management of FM (see Section 3 QS7 for example);
- add to the child’s developmental profile;
- inform risk assessment;
- inform individual support requirements eg for Special Educational Needs assessment/review;
- inform provision of further equipment such as audio adaptors for interactive whiteboard/PC/language labs or directional transmitter/conference microphone for use in discussion groups;
- refine use of the personal FM system eg selection of FM only programme, use of different transmitter options etc;
- highlight training needs of mainstream staff, other transmitter users and others;
- meet locally prescribed targets for audiological management; and
- contribute to service quality assurance.

Using questionnaires to evaluate a personal FM system fitting
(ii) A subjective observation schedule or questionnaire should be completed in addition to speech tests. For younger children, the questionnaires will be administered by the adults most closely involved with them. These questionnaires can be used regularly as ongoing evaluation tools. There is an acknowledged scarcity of published instruments, but suitable tools include:

Visit MCHAS website for examples of the following questionnaires.

For younger children
- Early Listening Function (ELF) (Anderson, 2002)
- Children’s Home Inventory for Listening Difficulties (CHILD) (Anderson and Smaldino, 2000)
  (Both these have no published psychometric parameters, but are used quite extensively for hearing aid evaluation)

From 7 years approx
- Listening Inventory For Education (LIFE) (Anderson and Smaldino, 1997) – some psychometric parameters published
- Children’s Outcomes Worksheet (COW) (Whitelaw, Williams et al, 2001) – no published psychometric parameters, but adapted from a well-validated adult hearing aid evaluation questionnaire i.e Client-Orientated Scale of Improvement (COSI Dillon, James et al, 1997); used in Oticon study of FM systems in the classroom.
- Listening Situations Questionnaire (LSQ) (Grimshaw, 1998) – some psychometric properties researched during development, but unpublished.

An FM questionnaire is being developed by FM working group members contact either mary.hostler@manchester.ac.uk or carina@laundrylane.co.uk if you would like to take part in studies involving this questionnaire (Primary and Secondary versions). Once a child reaches an age when they can co-operate with such measures the questionnaire should include their views as well.
(iii) Equipment for a Speech in Noise Evaluation procedure

**Recorded speech material**
There are severe limitations in the availability (in the UK) of a range of appropriate speech test materials which have been equated for difficulty between lists/sentences in noise. However, acknowledging these limitations, it is still possible and important to assess and compare the child’s performance in HA and HA+FM conditions.

Live voice can be used ‘in the field’, as in the Ewing Foundation video/DVD *Getting It Right* (Pither 2004) and could also be used in a clinical situation. However, it requires two testers and meticulous delivery and measurement of input levels. Use of recorded speech materials more easily ensures the consistency of the level of presentation and the ability to adapt the levels used.

**Test room**
Even using recorded materials, there will be unacceptable variations due to room acoustics if the ‘critical distance’ (see Boothroyd, 2004) is exceeded when the child is positioned for testing. Every effort should be made to keep ambient noise in the room to a minimum, and the noise level should be measured and noted with the test results.

**Transmitter microphone placement**
When a transmitter microphone is placed next to a loudspeaker, the pattern of radiation produced is different from that obtained from a neck-worn microphone. However, the former procedure is easily calibrated, levels are adjustable, and repeatable evaluation results can be obtained.

Usually a transmitter microphone is worn 12cm from the speaker’s mouth, either around the neck or on a lapel. For this suggested procedure, the microphone needs to be closer to the amplifier in order to achieve an 80dBA input. In this position, less ambient noise will be picked up by the Tx microphone during testing than in a real-life situation. Take care not to place the transmitter microphone next to a speaker that has a large ‘woofer’ as this could mean that the higher frequencies may not be picked up and misleading results could ensue.

**Equipment**
A good quality loudspeaker must be used and all signals must be calibrated accurately (Martin, 1997). The following equipment was used in trials of this procedure:

- Parrot Speech Discrimination Tester, (AB wordlist handset) and speaker (Soundbyte Solutions)
- Clampstand to position the Tx microphone in front of the loudspeaker
- FOSTEX 6301b LOUDSPEAKER. This has a volume control and can be positioned on a stand with an adaptor so height is easily adjusted.
- Compressed classroom babble noise (CD, tape and soundfiles for computer are available from Graham Hamilton, Ewing Foundation)
- Sound level meter

(iv) Speech in Noise Evaluation Procedure

1. Ensure that the hearing aids are set correctly and working, and that the FM system has been set up correctly (see section on Fitting).

2. Select an appropriate speech test, giving consideration to the user’s developmental age and language skills (MCHAS, 2006). Explain the test procedure (repeating words, pointing to picture/toys etc) to the child, with suitable examples.

3. Seat the child at a distance of 75cm from, and facing, the loudspeaker (0˚ azimuth) which will deliver the speech signals. Place the loudspeaker for delivering the noise signal directly behind the child, 180˚ azimuth, at a distance of 1m. Both loudspeakers should be at ear level.
Diagram of test set up:

4. Set the dial of the Parrot to 60; use calibration tone and the sound level meter to check that it measures 60dBA at the child’s ear. Ensure that the child stays in that position. Deliver and score the first list, with child using hearing instruments only. This should be noted as the baseline score in quiet. The level can be increased, if necessary, to obtain the child’s optimal score (i.e. commensurate with usual best performance); in this case the noise levels will need adjusting accordingly. Some very young children, or those with special needs, may need live voice presentation first.

5. Introduce the noise to measure 60dBA at the child’s ear, giving a Signal to Noise Ratio (SNR) of 0dB. Deliver and score the next list. If the child is still scoring well, increase the noise in 5 dB steps until their performance has dropped to 50% or less, of the baseline score. (interim steps with SNR at +10dB and then at +5dB can be included eg if the degree of hearing loss is severe/profound).

6. Introduce the FM system (set up appropriately beforehand). Place the FM transmitter microphone in front of the loudspeaker delivering the speech, at a distance where the input to it is 75-80dBA as checked with a SLM. For example, when the dial of the Parrot is on 60, the Tx needs to be 2-3 cm from the speaker.

7. Deliver the next list with the noise at 60dBA (or higher, if necessary, as described above) and the speech signal delivered with 60 on the dial of the Parrot but measured at 80dBA into the Tx microphone and the FM system switched on at the correct setting.

8. Calculate the improvement from the worst score in noise to the score obtained through the FM system. Note the SNR at which this was obtained.

9. This procedure can be adapted for individual circumstances. For example, the SNR conditions tested can be chosen to reflect the typical classroom conditions, if these are known (eg SNR -5, -10, -20 etc). With a recording device and appropriate computer programme (Shaw, 2007) relatively easy measurement of the 'typical' SNR a child experiences can be measured across the course of a school day.

10. Evaluate the results.

- The speech scores in quiet should be commensurate with other speech scores obtained for the child during hearing aid evaluations.
- The score obtained in noise with the hearing instrument alone should be poorer than that obtained in quiet (i.e. 50% or less of the baseline score*). When the FM system is used, the score should improve, towards that obtained with the hearing aids in quiet. (NB a greater degree of benefit can be recorded using FM only; however, FM+M is the more usual setting for most children to retain audibility of their own voice.)

*It could be argued that this will mean every person tested is shown to benefit from a personal FM system. However if local data on normal hearing listeners is obtained for a specific test rig, using the speech material at different SNRs, then a child’s performance can be compared to a 'normal' performance and judgements about the necessity for an FM system can be made accordingly.
The AB word lists or BKB sentence lists should be suitable for many English speaking 7-16 year olds. It is important to give clear instructions how to respond, and there may be a need to lipread the child’s responses. The procedure can be used with other tests for younger children eg Manchester Junior Word list (MJW), Manchester Picture test (MPT), and the McCormick Toy Test (MTT) (Ousey et al, 1989). These tests have not, however had list/sentence equating carried out. The limitations of the speech in noise tests available must be taken into account when making comparisons.

**An example of a score sheet for evaluation procedure**
(Carry out listening check before test)

Name:
Date:
Speech Test: BKB/AB/MJW/MPT/MTT

<table>
<thead>
<tr>
<th>Signal level</th>
<th>Background Noise level: S.N.R.</th>
<th>FM Yes/No</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>60dBA</td>
<td>Quiet</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>increase signal if score less than expected</td>
<td>Quiet</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>60dBA</td>
<td>60dBA(SNR 0dB)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>increase noise until score is 50% or less of baseline</td>
<td>SNR =</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>80dBA into Tx</td>
<td>60dBA (or same as box above)</td>
<td>Yes</td>
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</table>

SNR =
There must be close liaison between health and education teams, including the exchange of written information, and joint training relating to the use of the child’s personal FM system (MCHAS).

(i) Here is an example of close liaison between health and education teams provided by Jacqui Gardiner, Senior Educational Audiologist, Somerset Hearing Support Team:

**Multi Agency working at the Cleary Centre**
The Cleary Centre has developed multi agency working over the past two years. The purpose built assessment and observation rooms have lent themselves to developing joint assessment clinics between professionals in Health and Education, working together with children and their parents/carers.

**Hearing aid fitting and review clinics**
Twice monthly clinics are held for children, their carers/parents and supporting professionals. These sessions are run by the Chief Paediatric Audiologist from Musgrove Park Hospital and the Senior Educational Audiologist, from the Hearing Support Team (HST). Babies, children and young people are fitted with their first hearing aids at these clinics. They are then called back on a regular basis to evaluate as to whether the hearing aid prescription is accurate, enabling the child to make best use of their residual hearing which is imperative in order to develop speech and language and access the curriculum. This evaluation requires input from parent/carer, child and supporting professionals; a questionnaire has been devised to ensure that everyone can contribute to the process. These clinics also allow parents/carers direct access to Health professionals for impression taking for moulds and repairs/spares for hearing aids.

**Joint Paediatric Assessment Clinics**
These clinics have been developed to support the child and its family when diagnosis of hearing loss is made. They are held on twice monthly basis and led by an ENT consultant with a team which includes representation from Audiology, Speech and Language Therapy, Somerset Hearing Support Team and Paediatrics.

At each session the team work together to ensure a consistent multi agency approach regarding the support package for the family. Appointment times can be from thirty minutes to an hour in length allowing parents/carers to discuss the diagnosis and ongoing management and treatment issues.

The clinic appointments are jointly managed by Health and Education. The Hearing Support Team have slots on each clinic where they can refer children directly, ensuring that any child causing concern can be seen quickly.

The clinic also reviews children, with regards to their hearing loss, discussing any necessity for medical intervention or referral to other agencies with the family.

**Children’s Hearing Services Working Group (CHSWG)**
This group consists of representation from Health, Education, Social Services and Parents. It meets at the Cleary Centre approximately four times a year. The group had been developed to ensure that all services supporting hearing impaired children and their families work in a co-ordinated way. The meetings allow professionals and parents to develop a greater understanding of the roles each plays in the support package for individuals with hearing impairment and enables joint initiatives to develop and be put into practice. CHSWGs also operate in the Mendip and South Somerset and in July of this year the first annual meeting of all three groups will take place.

A subcommittee of the Taunton CHSWG has been formed to look at developing an audit tool to evaluate parental opinions as to the service they receive at diagnosis and thereafter, the group will be using the audit framework devised by SCOPE. [www.scope.org.uk](http://www.scope.org.uk)